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TITLE DISK2 ---- 10/28/85  FIXED DISK BIOS

;--  INT  13  -------------------------------------------
;                                                        :
; FIXED DISK I/O INTERFACE                               :
;                                                        :
; THIS INTERFACE PROVIDES ACCESS TO FIXED DISKS          :
; THROUGH THE IBM FIXED DISK CONTROLLER.                 :
;                                                        :
;---------------------------------------------------------

;---------------------------------------------------------
; THE BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH     :
; SOFTWARE INTERRUPTS ONLY. ANY ADDRESSES PRESENT IN     :
; THE LISTINGS ARE INCLUDED ONLY FOR COMPLETENESS,       :
; NOT FOR REFERENCE. APPLICATIONS WHICH REFERENCE        :
; ABSOLUTE ADDRESSES WITHIN THE CODE SEGMENT             :
; VIOLATE THE STRUCTURE AND DESIGN OF BIOS.              :
;---------------------------------------------------------
;
; INPUT (AH = HEX VALUE)
;
;       (AH) = 00H  RESET DISK (DL = 80H,81H) / DISKETTE
;       (AH) = 01H  READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)
;                   NOTE: DL < 80H - DISKETTE
;                         DL > 80H - DISK
;       (AH) = 02H  READ THE DESIRED SECTORS INTO MEMORY
;       (AH) = 03H  WRITE THE DESIRED SECTORS FROM MEMORY
;       (AH) = 04H  VERIFY THE DESIRED SECTORS
;       (AH) = 05H  FORMAT THE DESIRED TRACK
;       (AH) = 06H  FORMAT THE DESIRED TRACK AND SET BAD SECTOR FLAGS
;       (AH) = 07H  FORMAT THE DRIVE STARTING AT THE DESIRED TRACK
;       (AH) = 08H  RETURN THE CURRENT DRIVE PARAMETERS
;
;       (AH) = 09H  INITIALIZE DRIVE PAIR CHARACTERISTICS
;                   INTERRUPT 41H POINTS TO DATA BLOCK
;       (AH) = 0AH  READ LONG
;       (AH) = 0BH  WRITE LONG
;                   NOTE: READ AND WRITE LONG ENCOMPASS
;                   512 BYTES + 4 BYTES OF ECC
;       (AH) = 0CH  SEEK
;       (AH) = 0DH  ALTERNATE DISK RESET (SEE DL)
;       (AH) = 0EH  READ SECTOR BUFFER
;       (AH) = 0FH  WRITE SECTOR BUFFER,
;                   (RECOMMENDED PRACTICE BEFORE FORMATTING)
;       (AH) = 10H TEST DRIVE READY
;       (AH) = 11H RECALIBRATE
;       (AH) = 12H CONTROLLER RAM DIAGNOSTIC
;       (AH) = 13H DRIVE DIAGNOSTIC
;       (AH) = 14H CONTROLLER INTERNAL DIAGNOSTIC
;
;                REGISTERS USED FOR FIXED DISK OPERATIONS
;
;                (DL)    -  DRIVE NUMBER      (80H-87H FOR DISK, VALUE CHECKED)
;                (DH)    -  HEAD NUMBER       (O-7D ALLOWED, NOT VALUE CHECKED)
;                (CH)    -  CYLINDER NUMBER   (0-1023D, NOT VALUE CHECKED) (SEE CL)
;                (CL)    -  SECTOR NUMBER     (1-17D, NOT VALUE CHECKED)
;
;                           NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED
;                                 IN THE HIGH 2 BITS OF THE CL REGISTER
;                                 (10 BITS TOTAL)
;                (AL)    -  NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,
;                                              FOR READ/WRITE LONG 1-79H)
;                           (INTERLEAVE VALUE FOR FORMAT 1-16D)
;                (ES:BX) -  ADORESS OF BUFFER FOR READS AND WRITES,
;                           (NOT REQUIRED FOR VERIFY)
;
; OUTPUT
;       AH = STATUS OF CURRENT OPERATION
;            STATUS BITS ARE DEFINED IN THE EQUATES BELOW
;       CY = 0  SUCCESSFUL OPERATION (AH= 00H ON RETURN)
;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)
;
;       NOTE:   ERROR 11H  INDICATES THAT THE DATA READ HAD A RECOVERABLE
;               ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM.  THE DATA
;               1S PROBABLY GOOD,   HOWEVER THE BIOS ROUTINE INDICATES AN
;               ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE
;               FOR  ITSELF.  THE  ERROR  MAY  NOT  RECUR  IF THE DATA IS
;               REWRITTEN. (AL) CONTAINS THE BURST LENGTH.
;
;       IF DRIVE PARAMETERS WERE REQUESTED,
;
;               DL = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES
;                    ATTACHED (0-2) (CONTROLLER CARD ZERO TALLY ONLY)
;               DH = MAXIMUM USEABLE VALUE FOR HEAD NUMBER
;               CH = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER
;               CL = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER
;                    AND CYLINDER NUMBER HIGH BITS
;
;       IF AN ERROR OCCURS ON READ DRIVE PARAMETERS,
;
;               AH = ERROR CODE (INIT_FAIL)
;               AL = CX = DX = 0
;
;       REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN
;       INFORMATION.
;
;       NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE
;              ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.
;
;-----------------------------------------------------------------------
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                        PAGE
                        ;---------------------------------------------------------
                        ;       ERROR RETURN STATUS  (AH)= ??H  WHEN  CY= 1      :
                        ;---------------------------------------------------------

 = 00FF                 SENSE_FAIL      EQU     0FFH            ; SENSE OPERATION FAILED
 = 00CC                 WRITE_FAULT     EQU     0CCH            ; WRITE FAULT ON SELECTED DRIVE
 = 00BB                 UNDEF_ERR       EQU     0BBH            ; UNDEFINED ERROR OCCURRED
 = 0080                 TIME_OUT        EQU     080H            ; ATTACHMENT FAILED TO RESPOND
 = 0040                 BAD_SEEK        EQU     040H            ; SEEK OPERATION FAILED
 = 0020                 BAD_CNTLR       EQU     020H            ; CONTROLLER HAS FAILED
 = 0011                 DATA_CORRECTED  EQU     011H            ; ECC CORRECTED DATA ERROR
 = 0010                 BAD_ECC         EQU     010H            ; BAD ECC ON DISK READ
 = 000B                 BAD_TRACK       EQU     00BH            ; BAD TRACK FLAG DETECTED
 = 0009                 DMA_BOUNDARY    EQU     009H            ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
 = 0007                 INIT_FAIL       EQU     007H            ; DRIVE PARAMETER ACTIVITY FAILED
 = 0005                 BAD_RESET       EQU     005H            ; RESET FAILED
 = 0004                 RECORD_NOT_FND  EQU     004H            ; REQUESTED SECTOR NOT FOUND
 = 0002                 BAD_ADDR_MARK   EQU     002H            ; ADDRESS MARK NOT FOUND
 = 0001                 BAD_CMD         EQU     001H            ; BAD COMMAND PASSED TO DISK I/O

                        ;----------------------------------------
                        ;       INTERRUPT AND STATUS AREAS      :
                        ;----------------------------------------

 0000                   ABS0    SEGMENT AT 0H
 0034                                   ORG     00DH*4          ; FIXED DISK INTERRUPT VECTOR
 0034                   HDISK_INT       LABEL   DWORD
 004C                                   ORG     013H*4          ; DISK INTERRUPT VECTOR
 004C                   ORG_VECTOR      LABEL   DWORD
 0064                                   ORG     019H*4          ; BOOTSTRAP INTERRUPT VECTOR
 0064                   BOOT_VEC        LABEL   DWORD
 0078                                   ORG     01EH*4          ; DISKETTE PARAMETERS
 0078                   DISKETTE_PARM   LABEL   DWORD
 0100                                   ORG     040H*4          ; NEW DISKETTE INTERRUPT VECTOR
 0100                   DISK_VECTOR     LABEL   DWORD
 0104                                   ORG     041H*4          ; FIXED DISK PARAMETER VECTOR
 0104                   HF_TBL_VEC      LABEL   DWORD
 7C00                                   ORG     7C00H           ; BOOTSTRAP LOADER VECTOR
 7C00                   BOOT_LOCN       LABEL   FAR
 7C00                   ABS0    ENDS

 0000                   DATA    SEGMENT AT 40H
 006C                                   ORG     06CH
 006C ????              TIMER_LOW       DW      ?               ; TIMER LOW WORD
 0072                                   ORG     072H
 0072 ????              RESET_FLAG      DW      ?               ; 1234H IF KEYBOARD RESET UNDERWAY
 0074                                   ORG     074H
 0074 ??                DISK_STATUS     DB      ?               ; FIXED DISK STATUS BYTE
 0075 ??                HF_NUM          DB      ?               ; COUNT OF FIXED DISK DRIVES
 0076 ??                CONTROL_BYTE    DB      ?               ; CONTROL BYTE DRIVE OPTIONS
 0077 ??                PORT_OFF        DB      ?               ; PORT OFFSET
 0078                   DATA    ENDS

 0000                   CODE    SEGMENT

                        ;---------------------------------------------------------
                        ; HARDWARE SPECIFIC VALUES                               :
                        ;                                                        :
                        ;  -  CONTROLLER I/O PORT                                :
                        ;     > WHEN READ FROM:                                  :
                        ;       HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU)   :
                        ;       HF_PORT+1 - READ CONTROLLER HARDWARE STATUS      :
                        ;                   (CONTROLLER TO CPU)                  :
                        ;       HF_PORT+2 - READ CONFIGURATION SWITCHES          :
                        ;       HF_PORT+3 - NOT USED                             :
                        ;     > WHEN WRITTEN TO:                                 :
                        ;       HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER)  :
                        ;       HF_PORT+1 - CONTROLLER RESET                     :
                        ;       HF_PORT+2 - GENERATE CONTROLLER SELECT PULSE     :
                        ;       HF_PORT+3 - WRITE PATTERN TO DMA AND INTERRUPT   :
                        ;                   MASK REGISTER                        :
                        ;                                                        :
                        ;---------------------------------------------------------

 =                      CMD_BLOCK       EQU     BYTE PTR [BP]-8 ; CMD_BLOCK HEAD
 = 0320                 HF_PORT         EQU     0320H           ; DISK PORT
 = 0020                 INTA00          EQU     020H            ; 8259 PORT
 = 0021                 INTA01          EQU     021H            ; 8259 PORT
 = 0020                 EOI             EQU     020H            ; END OF INTERRUPT COMMAND
 = 0008                 R1_BUSY         EQU     00001000B       ; DISK PORT 1 BUSY BIT
 = 0004                 R1_BUS          EQU     00000100B       ;              COMMAND/DATA BIT
 = 0002                 R1_IOMODE       EQU     00000010B       ;              MODE BIT
 = 0001                 R1_REQ          EQU     00000001B       ;              REQUEST BIT

 = 0047                 DMA_READ        EQU     01000111B       ; CHANNEL 3 (047H)
 = 004B                 DMA_WRITE       EQU     01001011B       ; CHANNEL 3 (04BH)
 = 0000                 DMA             EQU     000H            ; DMA ADDRESS
 = 0082                 DMA_HIGH        EQU     082H            ; PORT FOR HIGH 4 BITS OF DMA

 = 0000                 TST_RDY_CMD     EQU     00000000B       ; CNTLR READY (00H)
 = 0001                 RECAL_CMD       EQU     00000001B       ;       RECAL (01H)
 = 0003                 SENSE_CMD       EQU     00000011B       ;       SENSE (03H)
 = 0004                 FMTDRV_CMD      EQU     00000100B       ;       DRIVE (04H)
 = 0005                 CHK_TRK_CMD     EQU     00000101B       ;       T CHK (05H)
 = 0006                 FMTTRK_CMD      EQU     00000110B       ;       TRACK (06H)
 = 0007                 FMTBAD_CMD      EQU     00000111B       ;       BAD   (07H)
 = 0008                 READ_CMD        EQU     00001000B       ;       READ  (08H)
 = 000A                 WRITE_CMD       EQU     00001010B       ;       WRITE (0AH)
 = 000B                 SEEK_CMD        EQU     00001011B       ;       SEEK  (0BH)
 = 000C                 INIT_DRV_CMD    EQU     00001100B       ;       INIT  (0CH)
 = 000D                 RD_ECC_CMD      EQU     00001101B       ;       BURST (0DH)
 = 000E                 RD_BUFF_CMD     EQU     00001110B       ;       BUFFR (0EH)
 = 000F                 WR_BUFF_CMD     EQU     00001111B       ;       BUFFR (0FH)
 = 00E0                 RAM_DIAG_CMD    EQU     11100000B       ;       RAM   (E0H)
 = 00E3                 CHK_DRV_CMD     EQU     11100011B       ;       DRV   (E3H)
 = 00E4                 CNTLR_DIAG_CMD  EQU     11100100B       ;       CNTLR (E4H)
 = 00E5                 RD_LONG_CMD     EQU     11100101B       ;       RLONG (E5H)
 = 00E6                 WR_LONG_CMD     EQU     11100110B       ;       WLONG (E6H)

 = 0008                 MAX_FILE        EQU     8
 = 0002                 S_MAX_FILE      EQU     2
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                           PAGE
                                   ASSUME  CS:CODE,DS:ABS0
0000                               ORG     0H
0000 55                            DB      055H                    ; GENERIC BIOS HEADER
0001 AA                            DB      0AAH
0002 08                            DB      08D                     ; 4K MODULE

                           ;-----------------------------------------------------------------
                           ; FIXED DISK I/O SETUP                                           :
                           ;                                                                :
                           ;  - ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK               :
                           ;  - PERFORM POWER ON DIAGNOSTICS                                :
                           ;    SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED         :
                           ;                                                                :
                           ;-----------------------------------------------------------------

0003                       DISK_SETUP      PROC    FAR
0003 EB 35                         JMP     SHORT   L3
0005 35 39 58 37 32 39             DB      '59X7291 (C) COPYRIGHT IBM  CORP.'      ; COPYRIGHT NOTICE
     31 20 28 43 29 20
     43 4F 50 59 52 49
     47 48 54 20 49 42
     4D 20 20 43 4F 52
     50 2E
0025 2C 31 39 38 32 20             DB      ',1982 ,1985.'
     2C 31 39 38 35 2E
0031 20 31 30 2F 32 38             DB      ' 10/28/85'                             ; RELEASE MARKER
     2F 38 35
003A                       L3:
003A 2B C0                         SUB     AX,AX                                   ; ADDRESS LOW RAM
003C 8E D8                         MOV     DS,AX
003E FA                            CLI
003F A1 004C R                     MOV     AX,WORD PTR ORG_VECTOR                  ; LOAD DISKETTE IP
0042 A3 0100 R                     MOV     WORD PTR DISK_VECTOR,AX                 ; STORE AT INT 40H
0045 A1 004E R                     MOV     AX,WORD PTR ORG_VECTOR+2                ; LOAD DISKETTE CS
0048 A3 0102 R                     MOV     WORD PTR DISK_VECTOR+2,AX               ; STORE AT INT 40H
004B C7 06 004C R 0251 R           MOV     WORD PTR ORG_VECTOR,OFFSET DISK_IO      ; FIXED DISK HANDLER
0051 8C 0E 004E R                  MOV     WORD PTR ORG_VECTOR+2,CS                ;  AT INT 13H
0055 B8 0755 R                     MOV     AX,OFFSET HD_INT                        ; FIXED DISK INTERRUPT
0058 A3 0034 R                     MOV     WORD PTR HDISK_INT,AX                   ; HANDLER AT INT 0DH
005B 8C 0E 0036 R                  MOV     WORD PTR HDISK_INT+2,CS
005F C7 06 0064 R 0192 R           MOV     WORD PTR BOOT_VEC,OFFSET BOOT_STRAP     ; BOOTSTRAP ROUTINE AT
0065 8C 0E 0066 R                  MOV     WORD PTR BOOT_VEC+2,CS                  ;  INT 19H
0069 C7 06 0104 R 03FF R           MOV     WORD PTR HF_TBL_VEC,OFFSET FD_TBL       ; PARAMETER TABLE AT
006F 8C 0E 0106 R                  MOV     WORD PTR HF_TBL_VEC+2,CS                ;  INT 41H
0073 FB                            STI

                                   ASSUME  DS:DATA
0074 B8 ---- R                     MOV     AX,DATA                 ; ESTABLISH SEGMENT
0077 8E D8                         MOV     DS,AX
0079 C6 06 0074 R 00               MOV     DISK_STATUS,0           ; RESET THE STATUS INDICATOR
007E C6 06 0075 R 00               MOV     HF_NUM,0                ; ZERO COUNT OF DRIVES
0083 C6 06 0077 R 00               MOV     PORT_OFF,0              ; ZERO CARD OFFSET
0088 B9 0025                       MOV     CX,25H                  ; RETRY COUNT
008B                       L4:
008B E8 0177 R                     CALL    HD_RESET_1              ; RESET CONTROLLER
008E 73 05                         JNC     L7
0090 E2 F9                         LOOP    L4                      ; TRY RESET AGAIN
0092 E9 0154 R                     JMP     ERROR_EX
0095                       L7:
0095 B9 0001                       MOV     CX,1
0098 BA 0080                       MOV     DX,80H
009B B8 1200                       MOV     AX,1200H                ; CONTROLLER DIAGNOSTICS
009E CD 13                         INT     13H                     ;  CHECK THE INTERNAL RAM
00A0 73 03                         JNC     P7                      ;  BUFFERS
00A2 E9 0154 R                     JMP     ERROR_EX
00A5                       P7:
00A5 B8 1400                       MOV     AX,1400H                ; CONTROLLER DIAGNOSTICS
00A8 CD 13                         INT     13H                     ;  INTERNAL CHECKSUM AND
00AA 73 03                         JNC     P9                      ;  ECC CIRCUITRY TEST.
00AC E9 0154 R                     JMP     ERROR_EX
00AF                       P9:
00AF C7 06 006C R 0000             MOV     TIMER_LOW,0             ; ZERO TIMER
00B5 81 3E 0072 R 1234             CMP     RESET_FLAG,1234H        ; KEYBOARD RESET
00BB 75 06                         JNE     P8
00BD C7 06 006C R 019A             MOV     TIMER_LOW,410D          ; SKIP WAIT ON RESET
00C3                       P8:
00C3 FA                            CLI                             ; DISABLE INTERRUPTS
00C4 E4 21                         IN      AL,INTA01               ; TIMER
00C6 24 FE                         AND     AL,0FEH                 ; ENABLE TIMER
00C8 E6 21                         OUT     INTA01,AL               ; START TIMER
00CA FB                            STI                             ; INTERRUPTS ON
00CB                       P4:
00CB E8 0177 R                     CALL    HD_RESET_1              ; RESET CONTROLLER
00CE 72 07                         JC      P10
00D0 B8 1000                       MOV     AX,1000H                ; TEST TO SEE IF THE DRIVE
00D3 CD 13                         INT     13H                     ;  IS READY
00D5 73 0A                         JNC     P2
00D7                       P10:
00D7 A1 006C R                     MOV     AX,TIMER_LOW
00DA 3D 01BE                       CMP     AX,446D                 ; 25 SECONDS
00DD 72 EC                         JB      P4
00DF EB 73                         JMP     SHORT ERROR_EX
00E1                       P2:
00E1 B8 1100                       MOV     AX,1100H                ; RECALIBRATE THE DRIVE 0
00E4 CD 13                         INT     13H
00E6 72 6C                         JC      ERROR_EX

00E8 B8 0900                       MOV     AX,0900H                ; SET DRIVE PARAMETERS
00EB CD 13                         INT     13H                     ;  FOR DRIVE 0
00ED 72 65                         JC      ERROR_EX

00EF B8 C800                       MOV     AX,0C800H               ; DMA TO BUFFER
00F2 8E C0                         MOV     ES,AX                   ; SET SEGMENT
00F4 2B DB                         SUB     BX,BX
00F6 B8 0F00                       MOV     AX,0F00H                ; WRITE SECTOR BUFFER
00F9 CD 13                         INT     13H
00FB 72 57                         JC      ERROR_EX

00FD FE 06 0075 R                  INC     HF_NUM                  ; DRIVE ZERO RESPONDED
0101 BA 0213                       MOV     DX,213H                 ; EXPANSION BOX
0104 B0 00                         MOV     AL,0
0106 EE                            OUT     DX,AL                   ; TURN BOX OFF
0107 BA 0321                       MOV     DX,321H                 ; TEST IF CONTROLLER
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010A EC                            IN      AL,DX                   ; ... IS IN THE SYSTEM UNIT
010B 24 0F                         AND     AL,0FH
010D 3C 0F                         CMP     AL,0FH
010F 74 06                         JE      BOX_ON
0111 C7 06 006C R 01A4             MOV     TIMER_LOW,420D          ; CONTROLLER IS IN SYSTEM UNIT
0117                       BOX_ON:
0117 BA 0213                       MOV     DX,213H                 ; EXPANSION BOX
011A B0 FF                         MOV     AL,0FFH
011C EE                            OUT     DX,AL                   ; TURN BOX ON
011D B9 0001                       MOV     CX,1                    ; ATTEMPT NEXT DRIVES
0120 BA 0081                       MOV     DX,081H
0123                       P3:
0123 2B C0                         SUB     AX,AX                   ; RESET THE CONTROLLER
0125 CD 13                         INT     13H
0127 72 42                         JC      POD_DONE
0129 B8 1100                       MOV     AX,01100H               ; RECALIBRATE THE DRIVE
012C CD 13                         INT     13H
012E 73 0A                         JNC     P5
0130 A1 006C R                     MOV     AX,TIMER_LOW
0133 3D 01BE                       CMP     AX,446D                 ; 25 SECONDS
0136 72 EB                         JB      P3
0138 EB 31                         JMP     SHORT POD_DONE
013A                       P5:
013A B8 0900                       MOV     AX,0900H                ; INITIALIZE DRIVE CHARACTERISTICS
013D CD 13                         INT     13H                     ;  FOR DRIVE 1
013F 72 2A                         JC      POD_DONE
0141 FE 06 0075 R                  INC     HF_NUM                  ; TALLY ANOTHER DRIVE
0145 81 FA 0081                    CMP     DX,(80H + S_MAX_FILE - 1)
0149 73 20                         JAE     POD_DONE
014B 42                            INC     DX
014C EB D5                         JMP     P3

014E 31 37 30 31 0D 0A     F17     DB      '1701',0DH,0AH          ; POST MESSAGE
= 0006                     F17L    EQU     $-F17

                           ;-----  POD ERROR

0154                       ERROR_EX:
0154 BD 000F                       MOV     BP,0FH                  ; POD ERROR FLAG
0157 2B F6                         SUB     SI,SI
0159 B9 0006                       MOV     CX,F17L                 ; MESSAGE CHARACTER COUNT
015C B7 00                         MOV     BH,0                    ; PAGE ZERO
015E                       OUT_CH:
015E 2E: 8A 84 014E R              MOV     AL,CS:F17[SI]           ; GET BYTE
0163 B4 0E                         MOV     AH,14D                  ; VIDEO OUT
0165 CD 10                         INT     10H                     ; DISPLAY CHARACTER
0167 46                            INC     SI                      ; NEXT CHAR
0168 E2 F4                         LOOP    OUT_CH                  ; DO MORE
016A F9                            STC
016B                       POD_DONE:
016B FA                            CLI                             ; NO INTERRUPTS
016C E4 21                         IN      AL,INTA01               ; READ THE INTERRUPT MASK
016E 0C 01                         OR      AL,01H                  ; DISABLE THE TIMER
0170 E6 21                         OUT     INTA01,AL
0172 FB                            STI                             ; ENABLE INTERRUPTS
0173 E8 0232 R                     CALL    DSBL                    ; DISABLE THE CARD MASKS
0176 CB                            RET

0177                       HD_RESET_1      PROC    NEAR
0177 51                            PUSH    CX                      ; SAVE REGISTER
0178 52                            PUSH    DX
0179 B9 0100                       MOV     CX,0100H                ; RETRY COUNT
017C                       L6:
017C E8 076D R                     CALL    PORT_0
017F 42                            INC     DX                      ; ADDRESS PORT_1
0180 EE                            OUT     DX,AL                   ; RESET CARD
0181 EB 00                         JMP     $+2                     ; I/O DELAY AT LEAST +5us
0183 EB 00                         JMP     $+2                     ; ALLOW TIME TO CLEAR THE
0185 EB 00                         JMP     $+2                     ;  HARDWARE STATUS REGISTER
0187 EC                            IN      AL,DX                   ; READ THE HARDWARE STATUS
0188 24 3F                         AND     AL,00111111B            ; MASK OFF UPPER 2 BITS AND CLEAR CY
018A 74 03                         JZ      R3                      ; EXIT IF REGISTER IS CLEARED WITH CY=0
018C E2 EE                         LOOP    L6                      ; TRY AGAIN
018E F9                            STC                             ; SET ERROR CONDITION CY=1
018F                       R3:
018F 5A                            POP     DX                      ; RESTORE REGISTER
0190 59                            POP     CX
0191 C3                            RET
0192                       HD_RESET_1      ENDP
0192                       DISK_SETUP      ENDP
```

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                             PAGE
                             ;---  INT  19 H -----------------------------------------------
                             ;                                                             :
                             ; INTERRUPT 19 BOOT STRAP LOADER                              :
                             ;                                                             :
                             ;  -  THE FIXED DISK BIOS REPLACES THE INTERRUPT 19H BOOT     :
                             ;      STRAP VECTOR WITH A POINTER TO THIS BOOT ROUTINE AND   :
                             ;      RESETS THE DEFAULT DISK AND DISKETTE PARAMETER VECTORS :
                             ;                                                             :
                             ;  -  THE BOOT BLOCK TO BE READ IN WILL BE ATTEMPTED FROM     :
                             ;      CYLINDER 0 SECTOR 1 OF THE DEVICE.                     :
                             ;                                                             :
                             ;  -  THE BOOTSTRAP SEQUENCE IS:                              :
                             ;      ATTEMPT TO LOAD FROM THE DISKETTE INTO THE BOOT        :
                             ;      LOCATION (0000:7C00H) WHERE CONTROL IS TRANSFERRED.    :
                             ;      IF THE DISKETTE FAILS THE FIXED DISK IS TRIED FOR A    :
                             ;      VALID BOOTSTRAP BLOCK. A VALID BOOT BLOCK ON THE       :
                             ;      FIXED DISK CONSISTS OF THE BYTES 055H 0AAH AS THE      :
                             ;      LAST TWO BYTES OF THE BLOCK.                           :
                             ;      IF THE ABOVE FAILS CONTROL IS PASSED TO RESIDENT BASIC :
                             ;                                                             :
                             ;-------------------------------------------------------------

0192                         BOOT_STRAP:
                                     ASSUME  DS:ABS0,ES:ABS0
0192 2B C0                           SUB     AX,AX
0194 8E D8                           MOV     DS,AX                   ; ESTABLISH SEGMENT
0196 B4 C0                           MOV     AH,0C0H
0198 CD 15                           INT     15H                     ; READ CONFIGURATION PARAMETERS
                                                                     ; IF XT OR PC, INTERRUPTS ARE DISABLED
                             ;-----  RESET PARAMETER VECTORS         ;  AT THIS POINT.

019A FA                              CLI
019B C7 06 0104 R 03FF R             MOV     WORD PTR HF_TBL_VEC,OFFSET FD_TBL
01A1 8C 0E 0106 R                    MOV     WORD PTR HF_TBL_VEC+2,CS
01A5 73 0A                           JNC     H0                      ; JMP IF INT 15 FUNCTION IMPLEMENTED

01A7 C7 06 0078 R 0227 R             MOV     WORD PTR DISKETTE_PARM,OFFSET DISKETTE_TBL
01AD 8C 0E 007A R                    MOV     WORD PTR DISKETTE_PARM+2,CS
01B1                         H0:
01B1 FB                              STI

                             ;-----  ATTEMPT BOOTSTRAP FROM DISKETTE

01B2 2B D2                           SUB     DX,DX                   ; DRIVE ZERO

                             ;-----  ESTABLISH ES:BX POINTER

01B4 8E C2                           MOV     ES,DX                   ; ESTABLISH SEGMENT
01B6 BB 7C00 R                       MOV     BX,OFFSET BOOT_LOCN     ; SET BX TO 7C00H

                             ;-----  CLEAR  BOOT_LOCN

01B9 FC                              CLD                             ; DIRECTION FORWARD
01BA 33 C0                           XOR     AX,AX
01BC B9 0100                         MOV     CX,256                  ; CLEAR 256 WORDS
01BF 8B FB                           MOV     DI,BX                   ; POINT TO BOOT LOCATION BUFFER
01C1 F3/ AB                          REP     STOSW                   ; ZERO THE BOOT LOCATION BUFFER

01C3 B9 0004                         MOV     CX,4                    ; SET RETRY COUNT
01C6                         H1:                                     ; IPL_SYSTEM
01C6 51                              PUSH    CX                      ; SAVE RETRY COUNT
01C7 2B C0                           SUB     AX,AX                   ; RESET THE DISKETTE
01C9 CD 13                           INT     13H                     ; FILE IO CALL
01CB 72 08                           JC      H2                      ; IF ERROR, TRY AGAIN

01CD B8 0201                         MOV     AX,0201H                ; READ IN THE SINGLE SECTOR
01D0 B9 0001                         MOV     CX,1                    ; SECTOR 1, TRACK 0,
01D3 CD 13                           INT     13H                     ; FILE IO CALL
01D5 59                      H2:     POP     CX                      ; RECOVER RETRY COUNT
01D6 73 09                           JNC     H3                      ; CARRY FLAG SET BY UNSUCCESSFUL READ

01D8 80 FC 80                        CMP     AH,80H                  ; IF TIME OUT, NO RETRY
01DB 74 22                           JZ      H6                      ; TRY FIXED DISK

01DD E2 E7                           LOOP    H1                      ; DO IT FOR RETRY TIMES
01DF EB 1E                           JMP     SHORT H6                ; UNABLE TO IPL FROM THE DISKETTE

01E1 80 3E 7C00 R 06         H3:     CMP     BYTE PTR BOOT_LOCN,06H  ; CHECK FOR FIRST INSTRUCTION INVALID
01E6 72 3D                           JB      H10                     ; IF BOOT NOT VALID, GO TO BASIC

                             ;-----  INSURE DATA PATTERN FIRST 8 WORDS NOT ALL EQUAL

01E8 BF 7C00 R                       MOV     DI,OFFSET BOOT_LOCN     ; CHECK DATA PATTERN
01EB B9 0008                         MOV     CX,8                    ; CHECK THE NEXT 8 WORDS
01EE A1 7C00 R                       MOV     AX,WORD PTR BOOT_LOCN   ; LOAD THE FIRST WORD

01F1 83 C7 02                H4:     ADD     DI,2                    ; POINT TO NEXT WORD
01F4 3B 05                           CMP     AX,[DI]                 ; CHECK DATA PATTERN FOR A FILL PATTERN
01F6 E1 F9                           LOOPZ   H4
01F8 74 2B                           JZ      H10                     ; BOOT NOT VALID, GO TO BASIC
01FA                         H5:
01FA EA 7C00 ---- R                          JMP     BOOT_LOCN

                             ;-----  ATTEMPT BOOTSTRAP FROM FIXED DISK

01FF                         H6:
01FF 2B C0                           SUB     AX,AX                   ; RESET DISKETTE
0201 CD 13                           INT     13H
0203 B9 0003                         MOV     CX,3                    ; SET RETRY COUNT
0206 BA 0080                         MOV     DX,0080H                ; FIXED DISK ZERO
0209                         H7:                                     ; IPL_SYSTEM
0209 51                              PUSH    CX                      ; SAVE RETRY COUNT
020A 2B C0                           SUB     AX,AX                   ; RESET THE FIXED DISK
020C CD 13                           INT     13H                     ; FILE IO CALL
020E 72 08                           JC      H8                      ; IF ERROR, TRY AGAIN

                             ;-----  ES AND BX ALREADY ESTABLISHED

0210 B8 0201                         MOV     AX,0201H                ; READ IN THE SINGLE SECTOR
0213 B9 0001                         MOV     CX,1                    ; SECTOR 1, TRACK 0
0216 CD 13                           INT     13H                     ; FILE IO CALL
0218 59                      H8:     POP     CX                      ; RECOVER RETRY COUNT
0219 72 08                           JC      H9
```

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021B A1 7DFE R                     MOV     AX,WORD PTR BOOT_LOCN+510D
021E 3D AA55                       CMP     AX,0AA55H               ; TEST FOR GENERIC BOOT BLOCK
0221 74 D7                         JZ      H5                      ; GO TO BOOT LOCATION
0223                       H9:
0223 E2 E4                         LOOP    H7                      ; DO IT FOR RETRY TIMES

                           ;-----  UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK

0225                       H10:
0225 CD 18                         INT     18H                     ; RESIDENT BASIC

0227                       DISKETTE_TBL:

0227 CF                            DB      11001111B               ; SRT=D, HD UNLOAD=OF - 1ST SPEC BYTE
0228 02                            DB      2                       ; HD LOAD=1, MODE=DMA - 2ND SPEC BYTE
0229 25                            DB      25H                     ; MOTOR TIMEOUT AFTER OPERATION
022A 02                            DB      2                       ; 512 BYTES PER SECTOR
022B 08                            DB      8                       ; EOT (LAST SECTOR ON TRACK)
022C 2A                            DB      02AH                    ; GAP LENGTH
022D FF                            DB      0FFH                    ; OTL
022E 50                            DB      050H                    ; GAP LENGTH FOR FORMAT
022F F6                            DB      0F6H                    ; FILL BYTE FOR FORMAT
0230 19                            DB      25                      ; HEAD SETTLE TIME (MILLISECONDS)
0231 04                            DB      4                       ; MOTOR START TIME (1/8 SECOND)

                           ;-----  MAKE SURE THAT ALL HOUSEKEEPING IS DONE BEFORE EXIT

0232                       DSBL    PROC    NEAR
0232 2A C0                         SUB     AL,AL                   ; RESET INT/DMA MASK
0234 BA 0323                       MOV     DX,HF_PORT+3            ; LOAD FOR PORT_ADDRESS 3
0237 FA                            CLI                             ; DISABLE INTERRUPTS
0238 EE                            OUT     DX,AL                   ; RESET INT/DMA MASK CARD 0
0239 83 C2 04                      ADD     DX,4
023C EE                            OUT     DX,AL                   ; RESET INT/DMA MASK CARD 1
023D 83 C2 04                      ADD     DX,4
0240 EE                            OUT     DX,AL                   ; RESET INT/DMA MASK CARD 2
0241 83 C2 04                      ADD     DX,4
0244 EE                            OUT     DX,AL                   ; RESET INT/DMA MASK CARD 3

0245 B0 07                         MOV     AL,07H
0247 E6 0A                         OUT     DMA+10,AL               ; SET DMA MODE TO DISABLE TG
0249 E4 21                         IN      AL,INTA01
024B 0C 20                         OR      AL,020H
024D E6 21                         OUT     INTA01,AL               ; DISABLE IREQ 5
024F FB                            STI                             ; ENABLE INTERRUPTS
0250 C3                            RET
0251                       DSBL    ENDP

                           ;---  DISK_IO  -----------------------------------------
                           ;                                                       :
                           ;               FIXED DISK BIOS ENTRY POINT             :
                           ;                                                       :
                           ;-------------------------------------------------------

0251                       DISK_IO PROC    FAR
                                   ASSUME DS:DATA,ES:NOTHING
0251 80 FA 80                      CMP     DL,080H                 ; TEST FOR FIXED DISK DRIVE
0254 73 05                         JAE     HARD_DISK               ; YES, HANDLE HERE
0256 CD 40                         INT     40H                     ; DISKETTE HANDLER
0258                       RET_2:
0258 CA 0002                       RET     2                       ; BACK TO CALLER

025B                       HARD_DISK:
025B FB                            STI                             ; ENABLE INTERRUPTS
025C 0A E4                         OR      AH,AH
025E 75 09                         JNZ     A3
0260 CD 40                         INT     40H                     ; RESET NEC WHEN AH=0
0262 2A E4                         SUB     AH,AH
0264 80 FA 81                      CMP     DL,(80H+S_MAX_FILE-1)   ; DL IN LIMITS?
0267 77 EF                         JA      RET_2
0269                       A3:
0269 80 FC 08                      CMP     AH,8                    ; GET PARAMETERS IS A SPECIAL CASE
026C 75 03                         JNZ     A2
026E E9 0380 R                     JMP     GET_PARM_N
0271                       A2:
0271 55                            PUSH    BP                      ; SAVE THE BASE POINTER
0272 8B EC                         MOV     BP,SP                   ; LOAD THE CMD_BLOCK POINTER
0274 83 EC 08                      SUB     SP,8                    ; ALLOCATE SPACE FOR THE COMMAND BLOCK
                                                                   ;  ON THE STACK.
0277 53                            PUSH    BX                      ; SAVE REGISTERS DURING OPERATION
0278 51                            PUSH    CX
0279 52                            PUSH    DX
027A 1E                            PUSH    DS
027B 06                            PUSH    ES
027C 56                            PUSH    SI
027D 57                            PUSH    DI
027E BE ---- R                     MOV     SI,DATA
0281 8E DE                         MOV     DS,SI                   ; ESTABLISH DATA SEGMENT

0283 E8 02D0 R                     CALL    DISK_IO_CONT            ; PERFORM THE OPERATION

0286 50                            PUSH    AX
0287 E8 0232 R                     CALL    DSBL                    ; BE SURE DISABLES OCCURRED
028A B8 ---- R                     MOV     AX,DATA
028D 8E D8                         MOV     DS,AX                   ; ESTABLISH SEGMENT
028F 58                            POP     AX                      ; RESTORE THE REGISTERS
0290 8A 26 0074 R                  MOV     AH,DISK_STATUS          ; GET STATUS FROM OPERATION
0294 5F                            POP     DI
0295 5E                            POP     SI
0296 07                            POP     ES
0297 1F                            POP     DS
0298 5A                            POP     DX
0299 59                            POP     CX
029A 5B                            POP     BX

029B 83 C4 08                      ADD     SP,8                    ; ADJUST FOR THE COMMAND BLOCK.
029E 5D                            POP     BP                      ; RESTORE BASE POINTER
029F 80 FC 01                      CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
02A2 F5                            CMC                             ;  SUCCESS OR FAILURE
02A3 CA 0002                       RET     2                       ; THROW AWAY SAVED FLAGS
02A6                       DISK_IO ENDP
```

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                          PAGE
02A6                      M1      LABEL   WORD                     ; FUNCTION TRANSFER TABLE
02A6 032E R                       DW      DISK_RESET               ; 000H
02A8 0347 R                       DW      RETURN_STATUS            ; 001H
02AA 0350 R                       DW      DISK_READ                ; 002H
02AC 0359 R                       DW      DISK_WRITE               ; 003H
02AE 0362 R                       DW      DISK_VERF                ; 004H
02B0 0369 R                       DW      FMT_TRK                  ; 005H
02B2 036F R                       DW      FMT_BAD                  ; 006H
02B4 0375 R                       DW      FMT_DRV                  ; 007H
02B6 0326 R                       DW      BAD_COMMAND              ; 008H
02B8 043F R                       DW      INIT_DRV                 ; 009H
02BA 04F4 R                       DW      RD_LONG                  ; 00AH
02BC 0501 R                       DW      WR_LONG                  ; 00BH
02BE 0515 R                       DW      DISK_SEEK                ; 00CH
02C0 032E R                       DW      DISK_RESET               ; 00DH
02C2 051B R                       DW      RD_BUFF                  ; 00EH
02C4 0527 R                       DW      WR_BUFF                  ; 00FH
02C6 0533 R                       DW      TST_RDY                  ; 010H
02C8 0539 R                       DW      HDISK_RECAL              ; 011H
02CA 053F R                       DW      RAM_DIAG                 ; 012H
02CC 0545 R                       DW      CHK_DRV                  ; 013H
02CE 054B R                       DW      CNTLR_DIAG               ; 014H
= 002A                    M1L     EQU     $-M1

02D0                      DISK_IO_CONT    PROC    NEAR
02D0 80 FC 01                     CMP     AH,01H                   ; RETURN STATUS
02D3 74 72                        JE      RETURN_STATUS

02D5 80 EA 80                     SUB     DL,080H                  ; CONVERT DRIVE NUMBER TO 0 BASED RANGE
02D8 80 FA 08                     CMP     DL,MAX_FILE              ; LEGAL DRIVE TEST
02DB 73 49                        JAE     BAD_COMMAND

02DD C6 06 0074 R 00              MOV     DISK_STATUS,0            ; RESET THE STATUS INDICATOR

                          ;-----  SET UP COMMAND BLOCK

02E2 FE C9                        DEC     CL                       ; SECTORS 0-16 FOR CONTROLLER
02E4 C6 46 F8 00                  MOV     CMD_BLOCK+0,0            ; SET TO ZERO THE OP CODE
02E8 88 4E FA                     MOV     CMD_BLOCK+2,CL           ; SECTOR AND HIGH 2 BITS CYLINDER
02EB 88 6E FB                     MOV     CMD_BLOCK+3,CH           ; CYLINDER LOW
02EE 88 46 FC                     MOV     CMD_BLOCK+4,AL           ; INTERLEAVE / BLOCK COUNT
02F1 A0 0076 R                    MOV     AL,CONTROL_BYTE          ; CONTROL BYTE (STEP OPTION)
02F4 88 46 FD                     MOV     CMD_BLOCK+5,AL           ; SET THE CONTROL FIELD

                          ;-----  CALCULATE THE PORT OFFSET

02F7 8A EA                        MOV     CH,DL                    ; SAVE DL
02F9 80 CA 01                     OR      DL,1
02FC FE CA                        DEC     DL
02FE D0 E2                        SHL     DL,1                     ; GENERATE OFFSET
0300 88 16 0077 R                 MOV     PORT_OFF,DL              ; STORE OFFSET
0304 8A D5                        MOV     DL,CH                    ; RESTORE DL
0306 80 E2 01                     AND     DL,1                     ; MAKE DRIVE 0 OR 1
0309 B1 05                        MOV     CL,5                     ; SHIFT COUNT
030B D2 E2                        SHL     DL,CL                    ; DRIVE NUMBER (0,1)
030D 0A D6                        OR      DL,DH                    ; HEAD NUMBER
030F 88 56 F9                     MOV     CMD_BLOCK+1,DL           ; SET THE DRIVE AND HEAD

0312 8B C8                        MOV     CX,AX                    ; CALCULATE JUMP ADDRESS
0314 8A CD                        MOV     CL,CH                    ; GET INTO LOW BYTE
0316 32 ED                        XOR     CH,CH                    ; ZERO HIGH BYTE
0318 D1 E1                        SAL     CX,1                     ; *2 FOR TABLE LOOKUP
031A 8B F1                        MOV     SI,CX                    ; PUT INTO SI FOR BRANCH
031C 83 F9 2A                     CMP     CX,M1L                   ; TEST WITHIN RANGE
031F 73 05                        JNB     BAD_COMMAND
0321 2E: FF A4 02A6 R             JMP     WORD PTR CS:[SI+OFFSET M1]       ; GO DO THE COMMAND
0326                      BAD_COMMAND:
0326 C6 06 0074 R 01              MOV     DISK_STATUS,BAD_CMD      ; SET BAD COMMAND ERROR
032B B0 00                        MOV     AL,0
032D C3                           RET                              ; EXIT
032E                      DISK_IO_CONT    ENDP

                          ;-----------------------------------------------------------
                          ;       RESET THE DISK SYSTEM                  (AH = 000H)   :
                          ;-----------------------------------------------------------

032E                      DISK_RESET      PROC    NEAR
032E E8 076D R                    CALL    PORT_0                   ; RESET PORT
0331 42                           INC     DX                       ; PORT_1 ADDRESS
0332 EE                           OUT     DX,AL                    ; RESET CARD
0333 EB 00                        JMP     $+2                      ; I/O DELAY AT LEAST +5us
0335 EB 00                        JMP     $+2                      ; ALLOW TIME TO CLEAR THE
0337 EB 00                        JMP     $+2                      ;  HARDWARE STATUS REGISTER
0339 EC                           IN      AL,DX                    ; READ THE HARDWARE STATUS
033A 24 3F                        AND     AL,00111111B             ; MASK OFF UPPER 2 BITS AND CLEAR CY
033C 74 06                        JZ      DRI                      ; EXIT IF REGISTER IS CLEARED WITH CY=0
033E C6 06 0074 R 05              MOV     DISK_STATUS,BAD_RESET    ; SET THE ERROR CONDITION
0343 C3                           RET                              ; EXIT
0344                      DRI:
0344 E9 043F R                    JMP     INIT_DRV                 ; SET THE DRIVE PARAMETERS

0347                      DISK_RESET      ENDP

                          ;-----------------------------------------------------------
                          ;       DISK STATUS ROUTINE                    (AH = 001H)   :
                          ;-----------------------------------------------------------

0347                      RETURN_STATUS   PROC    NEAR
0347 A0 0074 R                    MOV     AL,DISK_STATUS           ; OBTAIN PREVIOUS STATUS
034A C6 06 0074 R 00              MOV     DISK_STATUS,0            ; RESET STATUS
034F C3                           RET
0350                      RETURN_STATUS   ENDP

                          ;-----------------------------------------------------------
                          ;       DISK READ ROUTINE                      (AH = 002H)   :
                          ;-----------------------------------------------------------

0350                      DISK_READ       PROC    NEAR
0350 B0 47                        MOV     AL,DMA_READ              ; MODE BYTE FOR DMA READ
0352 C6 46 F8 08                  MOV     CMD_BLOCK+0,READ_CMD
0356 E9 055E R                    JMP     DMA_OPN
0359                      DISK_READ       ENDP

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                           ;--------------------------------------------------------
                           ;       DISK WRITE ROUTINE                  (AH = 003H) :
                           ;--------------------------------------------------------

0359                       DISK_WRITE      PROC    NEAR
0359 B0 4B                         MOV     AL,DMA_WRITE            ; MODE BYTE FOR DMA WRITE
035B C6 46 F8 0A                   MOV     CMD_BLOCK+0,WRITE_CMD
035F E9 055E R                     JMP     DMA_OPN
0362                       DISK_WRITE      ENDP

                           ;--------------------------------------------------------
                           ;       DISK VERIFY                         (AH = 004H) :
                           ;--------------------------------------------------------

0362                       DISK_VERF       PROC    NEAR
0362 C6 46 F8 05                   MOV     CMD_BLOCK+0,CHK_TRK_CMD
0366 E9 054F R                     JMP     NDMA_OPN
0369                       DISK_VERF       ENDP

                           ;--------------------------------------------------------
                           ;       FORMATTING              (AH = 005H 006H C07H) :
                           ;--------------------------------------------------------

0369                       FMT_TRK PROC    NEAR                    ; FORMAT TRACK (AH = 005H)
0369 C6 46 F8 06                   MOV     CMD_BLOCK+0,FMTTRK_CMD
036D EB 0A                         JMP     SHORT   FMT_CONT
036F                       FMT_TRK ENDP

036F                       FMT_BAD PROC    NEAR                    ; FORMAT BAD TRACK (AH = 006H)
036F C6 46 F8 07                   MOV     CMD_BLOCK+0,FMTBAD_CMD
0373 EB 04                         JMP     SHORT   FMT_CONT
0375                       FMT_BAD ENDP

0375                       FMT_DRV PROC    NEAR                    ; FORMAT DRIVE (AH = 007H)
0375 C6 46 F8 04                   MOV     CMD_BLOCK+0,FMTDRV_CMD
0379                       FMT_DRV ENDP

0379                       FMT_CONT:
0379 80 66 FA C0                   AND     CMD_BLOCK+2,11000000B   ; ZERO OUT SECTOR FIELD
037D E9 054F R                     JMP     NDMA_OPN

                           ;--------------------------------------------------------
                           ;       GET PARAMETERS                          AH = 8) :
                           ;--------------------------------------------------------

0380                       GET_PARM_N      LABEL   NEAR
0380                       GET_PARM        PROC    FAR             ; GET DRIVE PARAMETERS
0380 1E                            PUSH    DS                      ; SAVE REGISTERS
0381 06                            PUSH    ES
0382 53                            PUSH    BX

                                   ASSUME  DS:ABS0
0383 2B C0                         SUB     AX,AX                   ; ESTABLISH ADDRESSING
0385 8E D8                         MOV     DS,AX
0387 C4 1E 0104 R                  LES     BX,HF_TBL_VEC

                                   ASSUME  DS:DATA
038B B8 ---- R                     MOV     AX,DATA
038E 8E D8                         MOV     DS,AX                   ; ESTABLISH SEGMENT
0390 80 EA 80                      SUB     DL,80H
0393 80 FA 08                      CMP     DL,MAX_FILE             ; TEST WITHIN RANGE
0396 73 57                         JAE     G4
0398 C6 06 0074 R 00               MOV     DISK_STATUS,0           ; RESET THE STATUS INDICATOR
039D 8A EA                         MOV     CH,DL                   ; SAVE THE DRIVE
039F 80 CA 01                      OR      DL,1
03A2 FE CA                         DEC     DL
03A4 D0 E2                         SHL     DL,1                    ; GENERATE OFFSET
03A6 88 16 0077 R                  MOV     PORT_OFF,DL             ; STORE OFFSET
03AA 8A D5                         MOV     DL,CH                   ; RESTORE DL
03AC 80 E2 01                      AND     DL,00000001B            ; DRIVE 0 OR DRIVE 1
03AF 8A E2                         MOV     AH,DL
03B1 E8 076D R                     CALL    PORT_0
03B4 42                            INC     DX                      ; PORT_2 ADDRESS
03B5 42                            INC     DX
03B6 EC                            IN      AL,DX                   ; READ SWITCH SETTINGS
03B7 80 FC 00                      CMP     AH,0                    ; DRIVE 0 OR 1
03BA 75 04                         JNZ     G0
03BC D0 E8                         SHR     AL,1                    ; RIGHT JUSTIFY THE SWITCH BITS
03BE D0 E8                         SHR     AL,1
03C0                       G0:
03C0 24 03                         AND     AL,00000011B            ; ISOLATE THE TABLE BITS
03C2 B1 04                         MOV     CL,4                    ; TABLE LENGTH IS 16 BYTES
03C4 D2 E0                         SHL     AL,CL                   ; ADJUST
03C6 2A E4                         SUB     AH,AH
03C8 03 D8                         ADD     BX,AX
03CA 26: 8B 07                     MOV     AX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
03CD 2D 0002                       SUB     AX,2                    ; ADJUST FOR 0-N
                                                                   ; AND RESERVE LAST TRACK
03D0 8A E8                         MOV     CH,AL
03D2 25 0300                       AND     AX,0300H                ; HIGH TWO BITS OF CYLINDER
03D5 D1 E8                         SHR     AX,1
03D7 D1 E8                         SHR     AX,1
03D9 0C 11                         OR      AL,011H                 ; SECTORS
03DB 8A C8                         MOV     CL,AL
03DD 26: 8A 77 02                  MOV     DH,ES:[BX][2]           ; HEADS
03E1 FE CE                         DEC     DH                      ; 0-N RANGE
03E3 8A 16 0075 R                  MOV     DL,HF_NUM               ; DRIVE COUNT
03E7 2B C0                         SUB     AX,AX
03E9                       G5:
03E9 5B                            POP     BX                      ; RESTORE REGISTERS
03EA 07                            POP     ES
03EB 1F                            POP     DS
03EC CA 0002                       RET     2                       ; EXIT
03EF                       G4:
03EF C6 06 0074 R 07               MOV     DISK_STATUS,INIT_FAIL   ; OPERATION FAILED
03F4 B4 07                         MOV     AH,INIT_FAIL
03F6 2A C0                         SUB     AL,AL
03F8 2B D2                         SUB     DX,DX
03FA 2B C9                         SUB     CX,CX
03FC F9                            STC                             ; SET ERROR FLAG
03FD EB EA                         JMP     G5                      ; EXIT
03FF                       GET_PARM        ENDP
```

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                           PAGE
                           ;--------------------------------------------------------
                           ; INITIALIZE DRIVE CHARACTERISTICS                      :
                           ;                                                       :
                           ; FIXED DISK PARAMETER TABLE:                           :
                           ;                                                       :
                           ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:      :
                           ;                                                       :
                           ;       (1 WORD) - MAXIMUM NUMBER OF CYLINDERS          :
                           ;       (1 BYTE) - MAXIMUM NUMBER OF HEADS              :
                           ;       (1 WORD) - STARTING REDUCED WRITE CURRENT CYL   :
                           ;       (1 WORD) - STARTING WRITE PRECOMPENSATION CYL   :
                           ;       (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH        :
                           ;       (1 BYTE) - CONTROL BYTE (DRIVE STEP OPTION)     :
                           ;                  BIT    7 DISABLE DISK-ACCESS RETRIES :
                           ;                  BIT    6 DISABLE ECC RETRIES         :
                           ;                  BITS 5-3 ZERO                        :
                           ;                  BITS 2-0 DRIVE OPTION                :
                           ;       (1 BYTE) - STANDARD TIME OUT VALUE (SEE BELOW)  :
                           ;       (1 BYTE) - TIME OUT VALUE FOR FORMAT DRIVE      :
                           ;       (1 BYTE) - TIME OUT VALUE FOR CHECK DRIVE       :
                           ;       (1 WORD) - LANDING ZONE                         :
                           ;       (1 BYTE) - SECTORS/TRACK                        :
                           ;       (1 BYTE) - RESERVED FOR FUTURE USE              :
                           ;                                                       :
                           ;       - TO DYNAMICALLY DEFINE A SET OF PARAMETERS     :
                           ;         BUILD A TABLE OF VALUES AND PLACE THE         :
                           ;         CORRESPONDING VECTOR INTO INTERRUPT 41.       :
                           ;                                                       :
                           ;       NOTE:   THE DEFAULT TABLE IS VECTORED IN FOR    :
                           ;               AN INTERRUPT 19H (BOOTSTRAP)            :
                           ;                                                       :
                           ; ON THE CARD SWITCH SETTINGS                           :
                           ;                                                       :
                           ;                 DRIVE 0    DRIVE 1                    :
                           ;               -----------------------                 :
                           ;         ON    :          /          :                 :
                           ;               : -1-  -2- / -3-  -4- :                 :
                           ;         OFF   :          /          :                 :
                           ;               -----------------------                 :
                           ;                                                       :
                           ;       TRANSLATION TABLE                               :
                           ;                                                       :
                           ;       DRIVE 0  :  DRIVE 1  :  TABLE ENTRY             :
                           ;         1/2    :    3/4    :                          :
                           ;       -----------------------------------             :
                           ;        ON ON   :   ON ON   :       0                  :
                           ;        ON OFF  :   ON OFF  :       1                  :
                           ;        OFF ON  :   OFF ON  :       2                  :
                           ;        OFF OFF :   OFF OFF :       3                  :
                           ;                                                       :
                           ;--------------------------------------------------------

03FF                       FD_TBL:

                           ;-----  DRIVE TABLE 0

03FF 0132                          DW      0306D                   ; MAX CYLINDERS
0401 04                            DB      04D                     ; MAX HEADS
0402 0132                          DW      0306D                   ; START REDUCED WRITE CURRENT CYL
0404 0000                          DW      0                       ; START WRITE PRECOMPENSATION CYL
0406 0B                            DB      0BH                     ; MAX ECC BURST DATA LENGTH
0407 05                            DB      00000101B               ; CONTROL BYTE
0408 10                            DB      010H                    ; STANDARD TIME OUT
0409 C0                            DB      0C0H                    ; TIME OUT FOR FORMAT DRIVE
040A 28                            DB      028H                    ; TIME FOR CHECK DRIVE
040B 0132                          DW      0306D                   ; LANDING ZONE
040D 11                            DB      017D                    ; SECTORS/TRACK
040E 00                            DB      0                       ; RESERVED

                           ;-----  DRIVE TABLE 1

040F 0264                          DW      0612D                   ; MAX CYLINDERS
0411 04                            DB      04D                     ; MAX HEADS
0412 0264                          DW      0612D                   ; START REDUCED WRITE CURRENT CYL
0414 0000                          DW      0                       ; START WRITE PRECOMPENSATION CYL
0416 0B                            DB      0BH                     ; MAX ECC BURST DATA LENGTH
0417 05                            DB      000000101B              ; CONTROL BYTE
0418 28                            DB      028H                    ; STANDARD TIME OUT
0419 E0                            DB      0E0H                    ; TIME OUT FOR FORMAT DRIVE
041A 42                            DB      042H                    ; TIME FOR CHECK DRIVE
041B 0297                          DW      0663D                   ; LANDING ZONE
041D 11                            DB      017D                    ; SECTORS/TRACK
041E 00                            DB      0                       ; RESERVED

                           ;-----  DRIVE TABLE 2

041F 0267                          DW      0615D                   ; MAX CYLINDERS
0421 04                            DB      04D                     ; MAX HEADS
0422 0267                          DW      0615D                   ; START REDUCED WRITE CURRENT CYL
0424 012C                          DW      0300D                   ; START WRITE PRECOMPENSATION CYL
0426 0B                            DB      0BH                     ; MAX ECC BURST DATA LENGTH
0427 05                            DB      00000101B               ; CONTROL BYTE
0428 28                            DB      028H                    ; STANDARD TIME OUT
0429 E0                            DB      0E0H                    ; TIME OUT FOR FORMAT DRIVE
042A 42                            DB      042H                    ; TIME FOR CHECK DRIVE
042B 0267                          DW      0615D                   ; LANDING ZONE
042D 11                            DB      017D                    ; SECTORS/TRACK
042E 00                            DB      0                       ; RESERVED

                           ;-----  DRIVE TABLE 3

042F 0132                          DW      0306D                   ; MAX CYLINDERS
0431 08                            DB      08D                     ; MAX HEADS
0432 0132                          DW      0306D                   ; START REDUCED WRITE CURRENT CY
0434 0080                          DW      0128D                   ; START WRITE PRECOMPENSATION CYL
0436 0B                            DB      0BH                     ; MAX ECC BURST DATA LENGTH
0437 05                            DB      00000101B               ; CONTROL BYTE
0438 28                            DB      028H                    ; STANDARD TIME OUT
0439 E0                            DB      0E0H                    ; TIME OUT FOR FORMAT DRIVE
043A 42                            DB      042H                    ; TIME FOR CHECK DRIVE
043B 0150                          DW      0336D                   ; LANDING ZONE
043D 11                            DB      017D                    ; SECTORS/TRACK
043E 00                            DB      0                       ; RESERVED
```

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                           ;---------------------------------------------------------
                           ;       INITIALIZE DRIVE                     (AH = 09H) :
                           ;---------------------------------------------------------

043F                       INIT_DRV        PROC    NEAR

                           ;-----  DO DRIVE ZERO

043F C6 46 F8 0C                   MOV     CMD_BLOCK+0,INIT_DRV_CMD
0443 C6 46 F9 00                   MOV     CMD_BLOCK+1,0           ; SET FOR DRIVE 0
0447 E8 0458 R                     CALL    INIT_DRV_R              ; SEND THE PARAMETERS
044A 72 0B                         JC      INIT_DRV_OUT            ; ERROR?

                           ;-----  DO DRIVE ONE

044C C6 46 F8 0C                   MOV     CMD_BLOCK+0,INIT_DRV_CMD
0450 C6 46 F9 20                   MOV     CMD_BLOCK+1,00100000B   ; SET TO DRIVE 1
0454 E8 0458 R                     CALL    INIT_DRV_R              ; SEND THE PARAMETERS
0457                       INIT_DRV_OUT:
0457 C3                            RET                             ; EXIT
0458                       INIT_DRV        ENDP

0458                       INIT_DRV_R      PROC    NEAR
0458 2A C0                         SUB     AL,AL
045A E8 057C R                     CALL    COMMAND                 ; ISSUE THE COMMAND
045D 73 01                         JNC     B1                      ; DX = PORT 0 AFTER CALL
045F C3                            RET
0460                       B1:
0460 8C D9                         MOV     CX,DS                   ; SAVE SEGMENT

                                   ASSUME  DS:ABS0
0462 2B C0                         SUB     AX,AX
0464 8E D8                         MOV     DS,AX                   ; ESTABLISH SEGMENT
0466 C4 1E 0104 R                  LES     BX,HF_TBL_VEC           ; LOAD THE TABLE VECTOR
046A 8E D9                         MOV     DS,CX                   ; RESTORE SEGMENT

                                   ASSUME  DS:DATA
                           ;-----------------------------------------------:
                           ;       DETERMINE PARAMETER TABLE OFFSET        :
                           ;       USING CONTROLLER PORT TWO AND           :
                           ;       DRIVE NUMBER SPECIFIER (0-1)            :
                           ;-----------------------------------------------:
046C 42                            INC     DX
046D 42                            INC     DX                      ; ADDRESS PORT 2
046E EC                            IN      AL,DX                   ; READ THE SWITCH SETTINGS
046F 8A 66 F9                      MOV     AH,CMD_BLOCK+1
0472 80 E4 20                      AND     AH,00100000B            ; DRIVE 0 OR 1
0475 75 04                         JNZ     B2
0477 D0 E8                         SHR     AL,1                    ; ADJUST
0479 D0 E8                         SHR     AL,1
047B                       B2:
047B 24 03                         AND     AL,011B                 ; ISOLATE
047D B1 04                         MOV     CL,4
047F D2 E0                         SHL     AL,CL                   ; ADJUST
0481 2A E4                         SUB     AH,AH
0483 03 D8                         ADD     BX,AX
0485 B4 09                         MOV     AH,00001001B            ; SET MASK FOR DATA MODE CPU TO CARD

                           ;-----  SEND DRIVE PARAMETERS MOST SIGNIFICANT BYTE FIRST

0487 BF 0001                       MOV     DI,1                    ; SEND MSB OF MAX CYLINDER
048A E8 04E9 R                     CALL    INIT_DRV_S
048D 72 4C                         JC      B3

048F BF 0000                       MOV     DI,0                    ; SEND LSB OF MAX CYLINDER
0492 E8 04E9 R                     CALL    INIT_DRV_S
0495 72 44                         JC      B3

0497 BF 0002                       MOV     DI,2                    ; SEND THE MAXIMUM HEADS
049A E8 04E9 R                     CALL    INIT_DRV_S
049D 72 3C                         JC      B3

049F BF 0004                       MOV     DI,4                    ; SEND MSB OF REDUCE WRITE CURRENT
04A2 E8 04E9 R                     CALL    INIT_DRV_S              ;  CYLINDER
04A5 72 34                         JC      B3

04A7 BF 0003                       MOV     DI,3                    ; SEND LSB OF REDUCE WRITE CURRENT
04AA E8 04E9 R                     CALL    INIT_DRV_S              ;  CYLINDER
04AD 72 2C                         JC      B3

04AF BF 0006                       MOV     DI,6                    ; SEND MSB OF WRITE PRECOMP CYLINDER
04B2 E8 04E9 R                     CALL    INIT_DRV_S
04B5 72 24                         JC      B3

04B7 BF 0005                       MOV     DI,5                    ; SEND LSB OF WRITE PRECOMP CYLINDER
04BA E8 04E9 R                     CALL    INIT_DRV_S
04BD 72 1C                         JC      B3

04BF BF 0007                       MOV     DI,7                    ; SEND ECC BURST LENGTH
04C2 E8 04E9 R                     CALL    INIT_DRV_S
04C5 72 14                         JC      B3

04C7 BF 0008                       MOV     DI,8                    ; LOAD THE CONTROL BYTE AND PLACE IN
04CA 26: 8A 01                     MOV     AL,ES:[BX+DI]           ; MEMORY AT 40:76H
04CD A2 0076 R                     MOV     CONTROL_BYTE,AL

04D0 2B C9                         SUB     CX,CX
04D2 B4 0F                         MOV     AH,00001111B            ; SET THE MASK FOR STATUS MODE
04D4                       B5:
04D4 E8 068D R                     CALL    HD_WAIT                 ; GO WAIT FOR THE STATE TO HAPPEN
04D7 73 09                         JNC     B6                      ; JMP TO READ THE STATUS BYTE
04D9 E2 F9                         LOOP    B5                      ; TRY AGAIN
04DB                       B3:
04DB C6 06 0074 R 07               MOV     DISK_STATUS,INIT_FAIL   ; OPERATION FAILED
04E0 F9                            STC                             ; SET THE ERROR CONDITION
04E1 C3                            RET
04E2                       B6:
04E2 4A                            DEC     DX                      ; ADDRESS PORT 0
04E3 EC                            IN      AL,DX                   ; READ STATUS BYTE OF THE OPERATION
04E4 24 02                         AND     AL,2                    ; MASK ERROR BIT
04E6 75 F3                         JNZ     B3                      ; ERROR BIT SET?
04E8 C3                            RET
04E9                       INIT_DRV_R      ENDP
```

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                           ;-----  SEND THE BYTE OUT TO THE CONTROLLER

04E9                       INIT_DRV_S      PROC    NEAR
04E9 E8 068D R                     CALL    HD_WAIT                 ; GO WAIT FOR REQUEST
04EC 72 05                         JC      D1                      ;  AFTER CALL DX = PORT 1
04EE 4A                            DEC     DX                      ; ADDRESS PORT 0
04EF 26: 8A 01                     MOV     AL,ES:[BX+DI]
04F2 EE                            OUT     DX,AL                   ; WRITE THE DATA TO THE CARD
04F3                       D1:
04F3 C3                            RET
04F4                       INIT_DRV_S      ENDP

                           ;--------------------------------------------------------
                           ;       READ LONG                            (AH = 0AH) :
                           ;--------------------------------------------------------

04F4                       RD_LONG         PROC    NEAR
04F4 E8 050E R                     CALL    CHK_LONG                ; CHECK LIMITS
04F7 72 5F                         JC      G8
04F9 C6 46 F8 E5                   MOV     CMD_BLOCK+0,RD_LONG_CMD
04FD B0 47                         MOV     AL,DMA_READ
04FF EB 5D                         JMP     SHORT   DMA_OPN
0501                       RD_LONG         ENDP

                           ;--------------------------------------------------------
                           ;       WRITE LONG                           (AH = 0BH) :
                           ;--------------------------------------------------------

0501                       WR_LONG         PROC    NEAR
0501 E8 050E R                     CALL    CHK_LONG                ; CHECK LIMITS
0504 72 52                         JC      G8
0506 C6 46 F8 E6                   MOV     CMD_BLOCK+0,WR_LONG_CMD
050A B0 4B                         MOV     AL,DMA_WRITE
050C EB 50                         JMP     SHORT   DMA_OPN
050E                       WR_LONG         ENDP

050E                       CHK_LONG        PROC    NEAR
050E 8A 46 FC                      MOV     AL,CMD_BLOCK+4          ; LOAD THE NUMBER OF SECTORS
0511 3C 80                         CMP     AL,080H                 ; COMPARE WITH LIMITS
0513 F5                            CMC                             ; SET THE CONDITION
0514 C3                            RET
0515                       CHK_LONG        ENDP

                           ;--------------------------------------------------------
                           ;       SEEK                                 (AH = 0CH) :
                           ;--------------------------------------------------------

0515                       DISK_SEEK       PROC    NEAR
0515 C6 46 F8 0B                   MOV     CMD_BLOCK+0,SEEK_CMD
0519 EB 34                         JMP     SHORT   NDMA_OPN
051B                       DISK_SEEK       ENDP

                           ;--------------------------------------------------------
                           ;       READ SECTOR BUFFER                   (AH = 0EH) :
                           ;--------------------------------------------------------

051B                       RD_BUFF         PROC    NEAR
051B C6 46 F8 0E                   MOV     CMD_BLOCK+0,RD_BUFF_CMD
051F C6 46 FC 01                   MOV     CMD_BLOCK+4,1           ; ONLY ONE BLOCK
0523 B0 47                         MOV     AL,DMA_READ
0525 EB 37                         JMP     SHORT   DMA_OPN
0527                       RD_BUFF         ENDP

                           ;--------------------------------------------------------
                           ;       WRITE SECTOR BUFFER                  (AH = 0FH) :
                           ;--------------------------------------------------------

0527                       WR_BUFF         PROC    NEAR
0527 C6 46 F8 0F                   MOV     CMD_BLOCK+0,WR_BUFF_CMD
052B C6 46 FC 01                   MOV     CMD_BLOCK+4,1           ; ONLY ONE BLOCK
052F B0 4B                         MOV     AL,DMA_WRITE
0531 EB 2B                         JMP     SHORT   DMA_OPN
0533                       WR_BUFF         ENDP

                           ;--------------------------------------------------------
                           ;       TEST DISK READY                     (AH = 010H) :
                           ;--------------------------------------------------------

0533                       TST_RDY         PROC    NEAR
0533 C6 46 F8 00                   MOV     CMD_BLOCK+0,TST_RDY_CMD
0537 EB 16                         JMP     SHORT   NDMA_OPN
0539                       TST_RDY         ENDP

                           ;--------------------------------------------------------
                           ;       RECALIBRATE                         (AH = 011H) :
                           ;--------------------------------------------------------

0539                       HDISK_RECAL     PROC    NEAR
0539 C6 46 F8 01                   MOV     CMD_BLOCK+0,RECAL_CMD
053D EB 10                         JMP     SHORT   NDMA_OPN
053F                       HDISK_RECAL     ENDP
```

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                           PAGE
                           ;--------------------------------------------------------
                           ;       CONTROLLER RAM DIAGNOSTICS          (AH = 012H) :
                           ;--------------------------------------------------------

053F                       RAM_DIAG        PROC    NEAR
053F C6 46 F8 E0                   MOV     CMD_BLOCK+0,RAM_DIAG_CMD
0543 EB 0A                         JMP     SHORT   NDMA_OPN
0545                       RAM_DIAG        ENDP

                           ;--------------------------------------------------------
                           ;       DRIVE DIAGNOSTICS                   (AH = 013H) :
                           ;--------------------------------------------------------

0545                       CHK_DRV PROC    NEAR
0545 C6 46 F8 E3                   MOV     CMD_BLOCK+0,CHK_DRV_CMD
0549 EB 04                         JMP     SHORT   NDMA_OPN
054B                       CHK_DRV ENDP

                           ;--------------------------------------------------------
                           ;       CONTROLLER INTERNAL DIAGNOSTICS     (AH = 014H) :
                           ;--------------------------------------------------------

054B                       CNTLR_DIAG      PROC    NEAR
054B C6 46 F8 E4                   MOV     CMD_BLOCK+0,CNTLR_DIAG_CMD
054F                       CNTLR_DIAG      ENDP

                           ;--------------------------------------------------------
                           ;                    SUPPORT ROUTINES                   :
                           ;--------------------------------------------------------

054F                       NDMA_OPN:
054F B0 02                         MOV     AL,02H
0551 E8 057C R                     CALL    COMMAND                 ; ISSUE THE COMMAND
0554 72 22                         JC      G11
0556 EB 16                         JMP     SHORT   G3
0558                       G8:
0558 C6 06 0074 R 09               MOV     DISK_STATUS,DMA_BOUNDARY
055D C3                            RET
055E                       DMA_OPN:
055E E8 06A5 R                     CALL    DMA_SETUP               ; SET UP FOR DMA OPERATION
0561 72 F5                         JC      G8
0563 B0 03                         MOV     AL,03H
0565 E8 057C R                     CALL    COMMAND                 ; ISSUE THE COMMAND
0568 72 0E                         JC      G11
056A B0 03                         MOV     AL,03H
056C E6 0A                         OUT     DMA+10,AL               ; INITIALIZE THE DISK CHANNEL
056E                       G3:
056E FA                            CLI                             ; NO INTERRUPTS
056F E4 21                         IN      AL,INTA01               ; READ THE MASK
0571 24 DF                         AND     AL,0DFH                 ; ENABLE IRQ-5
0573 E6 21                         OUT     INTA01,AL               ; WRITE THE MASK OUT
0575 E8 0700 R                     CALL    WAIT_INT                ; PROCEDURE DOES STI
0578                       G11:
0578 E8 05AD R                     CALL    ERROR_CHK               ; SEE IF THERE IS AN ERROR
057B C3                            RET                             ; EXIT

                           ;--------------------------------------------------------
                           ; COMMAND                                               :
                           ;       THIS ROUTINE OUTPUTS THE COMMAND BLOCK          :
                           ; INPUT                                                 :
                           ;       AL = CONTROLLER DMA/INTERRUPT REGISTER MASK     :
                           ;                                                       :
                           ;--------------------------------------------------------

057C                       COMMAND PROC    NEAR
057C E8 076D R                     CALL    PORT_0                  ; GET THE BASE ADDRESS
057F 42                            INC     DX
0580 42                            INC     DX                      ; ADDRESS PORT 2
0581 EE                            OUT     DX,AL                   ; ISSUE CONTROLLER SELECT PULSE
0582 42                            INC     DX                      ; ADDRESS PORT
0583 2B C9                         SUB     CX,CX                   ; WAIT COUNT
0585 EE                            OUT     DX,AL                   ; WRITE OMA MASK REGISTER
0586 4A                            DEC     DX
0587 4A                            DEC     DX                      ; ADDRESS PORT 1
0588                       WAIT_BUSY:
0588 EC                            IN      AL,DX                   ; READ THE HARDWARE STATUS
0589 24 0F                         AND     AL,0FH
058B 3C 0D                         CMP     AL,R1_BUSY OR R1_BUS OR R1_REQ  ; CHECK FOR BUSY,COMMAND
058D 74 09                         JE      C1                              ;  AND REQUEST BITS
058F E2 F7                         LOOP    WAIT_BUSY               ; KEEP TRYING
0591 C6 06 0074 R 80               MOV     DISK_STATUS,TIME_OUT
0596 F9                            STC                             ; SET THE ERROR CONDITION
0597 C3                            RET                             ; ERROR RETURN
0598                       C1:
0598 B9 0006                       MOV     CX,6                    ; SET FOR 6 BYTES OF COMMAND
059B 4A                            DEC     DX                      ; ADDRESS PORT 0
059C 8B F5                         MOV     SI,BP                   ; SAVE THE BASE POINTER
059E 83 ED 08                      SUB     BP,8                    ; SET FIRST BYTE OF COMMAND BLOCK
05A1 FA                            CLI                             ; NO INTERRUPTS IN COMMAND SEQUENCE
05A2                       CM3:
05A2 8A 46 00                      MOV     AL,[BP]                 ; GET A COMMAND BYTE
05A5 EE                            OUT     DX,AL                   ; ALLOW AT LEAST 2us BETWEEN EACH BYTE
05A6 45                            INC     BP                      ;  ON SENDING THE COMMAND SEQUENCE
05A7 E2 F9                         LOOP    CM3                     ; DO MORE
05A9 8B EE                         MOV     BP,SI                   ; RESTORE THE BASE POINTER
05AB FB                            STI                             ; INTERRUPTS BACK ON
05AC C3                            RET
05AD                       COMMAND ENDP
```

```
                           PAGE
                           ;--------------------------------------------------------
                           ;                                                       :
                           ;                      SENSE STATUS BYTES               :
                           ;        BYTE 0                                         :
                           ;              BIT    7   ADDRESS VALID, WHEN SET       :
                           ;              BIT    6   SPARE, SET TO ZERO            :
                           ;              BITS 5-4   ERROR TYPE                    :
                           ;              BITS 3-0   ERROR CODE                    :
                           ;                                                       :
                           ;        BYTE 1                                         :
                           ;              BITS 7-6   ZERO                          :
                           ;              BIT    5   DRIVE (0-1)                   :
                           ;              BITS 4-0   HEAD NUMBER                   :
                           ;                                                       :
                           ;        BYTE 2                                         :
                           ;              BITS 7-5   CYLINDER HIGH                 :
                           ;              BITS 4-0   SECTOR NUMBER                 :
                           ;                                                       :
                           ;        BYTE 3                                         :
                           ;              BITS 7-0   CYLINDER LOW                  :
                           ;                                                       :
                           ;--------------------------------------------------------

05AD                       ERROR_CHK       PROC    NEAR
05AD A0 0074 R                     MOV     AL,DISK_STATUS          ; CHECK IF THERE WAS AN ERROR
05B0 0A C0                         OR      AL,AL                   ; ANYTHING IN AL?
05B2 75 01                         JNZ     G21
05B4 C3                            RET

                           ;--------------------------------
                           ;     PERFORM SENSE STATUS      :
                           ;--------------------------------
                                                                   ; SENSE STATUS CAN BE ISSUED MULTIPLE
                                                                   ;  TIMES
05B5                       G21:
05B5 C6 46 F8 03                   MOV     CMD_BLOCK+0,SENSE_CMD
05B9 2A C0                         SUB     AL,AL                   ; WRITE ZERO IN INT/DMA MASK
05BB E8 057C R                     CALL    COMMAND                 ; ISSUE SENSE STATUS COMMAND
05BE 72 26                         JC      G24                     ; CANNOT RECOVER-EXIT WITH COMMAND
                                                                   ;  ERROR
05C0 2B FF                         SUB     DI,DI                   ; SET INDEX POINTER TO ZERO
05C2 B9 0004                       MOV     CX,4                    ; READ FOUR BYTES
05C5 B4 0B                         MOV     AH,00001011B            ; SET MASK FOR DATA MODE CARD TO CPU
05C7                       G22:
05C7 E8 068D R                     CALL    HD_WAIT                 ; GO WAIT FOR DATA INPUT STATE
05CA 72 1A                         JC      G24
05CC 4A                            DEC     DX                      ; ADDRESS PORT 0
05CD EC                            IN      AL,DX                   ; READ THE DATA BYTE i
05CE 88 43 F8                      MOV     [DI+CMD_BLOCK],AL       ; STORE AWAY SENSE BYTES
05D1 47                            INC     DI                      ; NEXT DATA LOCATION co
05D2 E2 F3                         LOOP    G22                     ; LOOP TILL ALL FOUR READ.
05D4 B4 0F                         MOV     AH,00001111B            ; SET THE MASK FOR STATUS MODE
05D6 E8 068D R                     CALL    HD_WAIT                 ; GO WAIT FOR STATUS STATE
05D9 72 0B                         JC      G24
05DB 4A                            DEC     DX                      ; ADDRESS PORT 0
05DC EC                            IN      AL,DX                   ; READ THE STATUS BYTE
05DD A8 02                         TEST    AL,2                    ; SENSE OPERATION FAIL?
05DF 74 0F                         JZ      STAT_ERR                ; GO GET THE ERROR.

05E1 C6 06 0074 R FF               MOV     DISK_STATUS,SENSE_FAIL  ; SET SENSE OPERATION FAIL
05E6                       G24:
05E6 F9                            STC
05E7 C3                            RET
05E8                       ERROR_CHK       ENDP

05E8 061E R                T_0     DW      TYPE_0                  ; ERROR TYPE JUMP TABLE
05EA 062B R                        DW      TYPE_1
05EC 066D R                        DW      TYPE_2
05EE 067A R                        DW      TYPE_3

05F0                       STAT_ERR:
05F0 8A 5E F8                      MOV     BL,CMD_BLOCK+0          ; GET ERROR BYTE
05F3 8A C3                         MOV     AL,BL
05F5 24 0F                         AND     AL,0FH
05F7 80 E3 30                      AND     BL,00110000B            ; ISOLATE THE TYPE OF ERROR
05FA 2A FF                         SUB     BH,BH
05FC B1 03                         MOV     CL,3
05FE D3 EB                         SHR     BX,CL                   ; ADJUST
0600 2E: FF A7 05E8 R              JMP     WORD PTR CS:[BX + OFFSET T_0]

0605                       TYPE0_TABLE     LABEL   BYTE
0605 00 20 40 CC 80 00             DB      0,BAD_CNTLR,BAD_SEEK,WRITE_FAULT,TIME_OUT,0,BAD_CNTLR
     20
060C 00 40                         DB      0,BAD_SEEK
= 0009                     TYPE0_LEN       EQU     $-TYPE0_TABLE

060E                       TYPE1_TABLE     LABEL   BYTE
060E 04 10 02 00 04                DB      RECORD_NOT_FND,BAD_ECC,BAD_ADDR_MARK,0,RECORD_NOT_FND
0613 40 00 00 11 0B                DB      BAD_SEEK,0,0,DATA_CORRECTED,BAD_TRACK
= 000A                     TYPE1_LEN       EQU     $-TYPE1_TABLE

0618                       TYPE2_TABLE     LABEL   BYTE
0618 01 02 01                      DB      BAD_CMD,BAD_ADDR_MARK,BAD_CMD
= 0003                     TYPE2_LEN       EQU     $-TYPE2_TABLE

061B                       TYPE3_TABLE     LABEL   BYTE
061B 20 20 10                      DB      BAD_CNTLR,BAD_CNTLR,BAD_ECC
= 0003                     TYPE3_LEN       EQU     $-TYPE3_TABLE
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                           PAGE
                           ;-----  TYPE 0 ERROR

061E                       TYPE_0:
061E BB 0605 R                     MOV     BX,OFFSET TYPE0_TABLE
0621 3C 09                         CMP     AL,TYPE0_LEN            ; CHECK IF ERROR IS DEFINED
0623 73 62                         JAE     UNDEF_ERR_L
0625 2E: D7                        XLAT    CS:TYPE0_TABLE          ; TABLE LOOKUP
0627 A2 0074 R                     MOV     DISK_STATUS,AL          ; SET ERROR CODE
062A C3                            RET

                           ;-----  TYPE 1 ERROR

062B                       TYPE_1:
062B BB 060E R                     MOV     BX,OFFSET TYPE1_TABLE
062E 8B C8                         MOV     CX,AX
0630 3C 0A                         CMP     AL,TYPE1_LEN            ; CHECK IF ERROR IS DEFINED
0632 73 53                         JAE     UNDEF_ERR_L
0634 2E: D7                        XLAT    CS:TYPE1_TABLE          ; TABLE LOOKUP
0636 A2 0074 R                     MOV     DISK_STATUS,AL          ; SET ERROR CODE
0639 80 E1 08                      AND     CL,08H                  ; CORRECTED ECC
063C 80 F9 08                      CMP     CL,08H
063F 75 29                         JNZ     G30

                           ;-----  OBTAIN ECC ERROR BURST LENGTH

0641 C6 46 F8 0D                   MOV     CMD_BLOCK+0,RD_ECC_CMD
0645 2A C0                         SUB     AL,AL
0647 E8 057C R                     CALL    COMMAND                 ; ISSUE THE COMMAND
064A 72 1E                         JC      G30
064C B4 0B                         MOV     AH,00001011B            ; SET MASK FOR DATA INPUT CARD TO CPU
064E E8 068D R                     CALL    HD_WAIT                 ; GO WAIT FOR THE INPUT STATE
0651 72 17                         JC      G30
0653 4A                            DEC     DX                      ; ADDRESS PORT 0
0654 EC                            IN      AL,DX                   ; READ THE LENGTH OF THE ERROR
0655 8A C8                         MOV     CL,AL                   ;  CORRECTED AND SAVE IN CL
0657 B4 0F                         MOV     AH,00001111B            ; SET MASK FOR STATUS STATE
0659 E8 068D R                     CALL    HD_WAIT                 ; G0 WAIT FOR STATUS STATE
065C 72 0C                         JC      G30
065E 4A                            DEC     DX                      ; ADDRESS PORT 0
065F EC                            IN      AL,DX                   ; READ THE STATUS BYTE
0660 A8 02                         TEST    AL,2                    ; ERROR BIT SET?
0662 74 06                         JZ      G30
0664 C6 06 0074 R 20               MOV     DISK_STATUS,BAD_CNTLR
0669 F9                            STC
066A                       G30:
066A 8A C1                         MOV     AL,CL
066C C3                            RET

                           ;-----  TYPE 2 ERROR

066D                       TYPE_2:
066D BB 0618 R                     MOV     BX,OFFSET TYPE2_TABLE
0670 3C 03                         CMP     AL,TYPE2_LEN            ; CHECK IF ERROR IS DEFINED
0672 73 13                         JAE     UNDEF_ERR_L
0674 2E: D7                        XLAT    CS:TYPE2_TABLE          ; TABLE LOOKUP
0676 A2 0074 R                     MOV     DISK_STATUS,AL          ; SET ERROR CODE
0679 C3                            RET

                           ;-----  TYPE 3 ERROR

067A                       TYPE_3:
067A BB 061B R                     MOV     BX,OFFSET TYPE3_TABLE
067D 3C 03                         CMP     AL,TYPE3_LEN            ; CHECK IF ERROR IS DEFINED
067F 73 06                         JAE     UNDEF_ERR_L
0681 2E: D7                        XLAT    CS:TYPE3_TABLE          ; TABLE LOOKUP
0683 A2 0074 R                     MOV     DISK_STATUS,AL          ; SET ERROR CODE
0686 C3                            RET

0687                       UNDEF_ERR_L:
0687 C6 06 0074 R BB               MOV     DISK_STATUS,UNDEF_ERR
068C C3                            RET

                           ;---------------------------------------------------------
                           ; ON ENTRY AH CONTAINS THE CONTROLLER BUS STATUS DECODE :
                           ; MASK USED TO CHECK THE HARDWARE STATUS.               :
                           ;---------------------------------------------------------
068D                       HD_WAIT         PROC    NEAR
068D 51                            PUSH    CX                      ; SAVE CX
068E 2B C9                         SUB     CX,CX                   ; SET THE LOOP COUNT
0690                       L1:
0690 E8 076D R                     CALL    PORT_0
0693 42                            INC     DX                      ; PORT_1 ADDRESS
0694 EC                            IN      AL,DX                   ; READ THE HARDWARE STATUS
0695 24 0F                         AND     AL,00001111B            ; CLEAR UPPER NIBBLE OF HARDWARE STATUS
0697 3A C4                         CMP     AL,AH                   ; CHECK THE STATE WITH THE MASK
0699 74 08                         JZ      L2                      ; JMP IF O.K WITH CARRY CLEARED
069B E2 F3                         LOOP    L1                      ; TRY AGAIN
069D C6 06 0074 R 80               MOV     DISK_STATUS,TIME_OUT
06A2 F9                            STC                             ; SET ERROR CONDITION
06A3                       L2:
06A3 59                            POP     CX                      ; RESTORE CX
06A4 C3                            RET
06A5                       HD_WAIT         ENDP
```

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                        PAGE
                        ;-------------------------------------------------------
                        ; DMA_SETUP                                            :
                        ;       THIS ROUTINE SETS UP FOR DMA OPERATIONS.       :
                        ; INPUT                                                :
                        ;       (AL) = MODE BYTE FOR THE DMA                   :
                        ;       (ES:BX) = ADDRESS TO READ/WRITE THE DATA       :
                        ; OUTPUT                                               :
                        ;       (AX) DESTROYED                                 :
                        ;-------------------------------------------------------

06A5                    DMA_SETUP       PROC    NEAR
06A5 80 7E FC 81                CMP     CMD_BLOCK+4,81H         ; BLOCK COUNT OUT OF RANGE
06A9 72 02                      JB      J1

06AB F9                         STC                             ; SET THE ERROR CONDITION
06AC C3                         RET

06AD                    J1:
06AD FA                         CLI                             ; NO MORE INTERRUPTS
06AE E6 0C                      OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
06B0 B1 04                      MOV     CL,4                    ; SHIFT COUNT
06B2 E6 0B                      OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
06B4 8C C0                      MOV     AX,ES                   ; GET THE ES VALUE
06B6 D3 C0                      ROL     AX,CL                   ; ROTATE LEFT
06B8 8A E8                      MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
06BA 24 F0                      AND     AL,0F0H                 ; ZERO THE LOW NIBBLE FROM SEGMENT
06BC 03 C3                      ADD     AX,BX                   ; TEST FOR CARRY FROM ADDITION
06BE 80 D5 00                   ADC     CH,0                    ; CARRY MEANS HIGH 4 BITS MUST BE INC

06C1 8B F0                      MOV     SI,AX                   ; SAVE START ADDRESS
06C3 E6 06                      OUT     DMA+6,AL                ; OUTPUT LOW ADDRESS
06C5 8A C4                      MOV     AL,AH
06C7 E6 06                      OUT     DMA+6,AL                ; OUTPUT HIGH ADDRESS
06C9 8A C5                      MOV     AL,CH                   ; GET HIGH 4 BITS
06CB 24 0F                      AND     AL,0FH
06CD E6 82                      OUT     DMA_HIGH,AL             ; OUTPUT THE HIGH 4 BITS TO PAGE REG

                        ;-----  DETERMINE COUNT

06CF 8A 66 FC                   MOV     AH,CMD_BLOCK+4          ; RECOVER BLOCK COUNT
06D2 D0 E4                      SHL     AH,1                    ; MULTIPLY BY 512 BYTES PER SECTOR
06D4 32 C0                      XOR     AL,AL                   ; CLEAR LOW BYTE
06D6 48                         DEC     AX                      ; AND DECREMENT VALUE BY ONE

                        ;-----  HANDLE READ AND WRITE LONG (516D BYTE BLOCKS)

06D7 80 7E F8 E5                CMP     CMD_BLOCK+0,RD_LONG_CMD
06DB 74 06                      JE      ADD4

06DD 80 7E F8 E6                CMP     CMD_BLOCK+0,WR_LONG_CMD
06E1 75 0F                      JNE     J20
06E3                    ADD4:
06E3 B8 0204                    MOV     AX,516D                 ; ONE BLOCK (512) PLUS 4 BYTES ECC
06E6 53                         PUSH    BX
06E7 2A FF                      SUB     BH,BH
06E9 8A 5E FC                   MOV     BL,CMD_BLOCK+4
06EC 52                         PUSH    DX
06ED F7 E3                      MUL     BX                      ; BLOCK COUNT TIMES 516
06EF 5A                         POP     DX
06F0 5B                         POP     BX
06F1 48                         DEC     AX                      ; ADJUST
06F2                    J20:
06F2 8B C8                      MOV     CX,AX                   ; SAVE COUNT VALUE
06F4 E6 07                      OUT     DMA+7,AL                ; LOW BYTE OF COUNT
06F6 8A C4                      MOV     AL,AH
06F8 E6 07                      OUT     DMA+7,AL                ; HIGH BYTE OF COUNT
06FA FB                         STI                             ; INTERRUPTS BACK ON
06FB 8B C6                      MOV     AX,SI                   ; RECOVER ADDRESS VALUE
06FD 03 C1                      ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
06FF C3                         RET                             ; RETURN TO CALLER
                                                                ;   CY SET BY ABOVE IF ERROR
0700                    DMA_SETUP       ENDP
```

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                           PAGE
                           ;------------------------------------------------
                           ; WAIT_INT                                      :
                           ;       THIS ROUTINE WAITS FOR THE FIXED DISK   :
                           ;       CONTROLLER TO SIGNAL THAT AN INTERRUPT  :
                           ;       HAS OCCURRED.                           :
                           ;------------------------------------------------

0700                       WAIT_INT        PROC    NEAR
                                   ASSUME  DS:ABS0
0700 FB                            STI                             ; TURN ON INTERRUPTS
0701 8C DB                         MOV     BX,DS                   ; SAVE DS
0703 2B C0                         SUB     AX,AX
0705 8E D8                         MOV     DS,AX                   ; ESTABLISH SEGMENT
0707 C4 36 0104 R                  LES     SI,HF_TBL_VEC           ; LOAD THE TABLE VECTOR

                                   ASSUME  DS:DATA,ES:NOTHING
070B 8E DB                         MOV     DS,BX                   ; RESTORE DS

                           ;-----  SET TIMEOUT VALUES

070D 2A FF                         SUB     BH,BH
070F 26: 8A 5C 09                  MOV     BL,BYTE PTR ES:[SI][9]  ; LOAD THE STANDARD TIME OUT
0713 8A 66 F8                      MOV     AH,CMD_BLOCK+0
0716 80 FC 04                      CMP     AH,FMTDRV_CMD
0719 75 06                         JNZ     W5

071B 26: 8A 5C 0A                  MOV     BL,BYTE PTR ES:[SI][0AH]        ; LOAD THE FORMAT DRIVE
071F EB 09                         JMP     SHORT W4                        ;  TIME OUT VALUE
0721 80 FC E3              W5:     CMP     AH,CHK_DRV_CMD
0724 75 04                         JNZ     W4

0726 26: 8A 5C 0B                  MOV     BL,BYTE PTR ES:[SI][0BH]        ; LOAD THE CHECK DRIVE
072A                       W4:                                             ;  TIME OUT VALUE
072A F8                            CLC                             ; CLEAR CY
072B B8 9000                       MOV     AX,9000H                ; DEVICE WAIT INTERRUPT
072E CD 15                         INT     15H
0730 FB                            STI                             ; ENABLE INTERRUPTS FOR PC AND
                                                                   ;  XT MACHINES.
0731 2B C9                         SUB     CX,CX                   ; SET THE LOOP COUNT

                           ;-----  WAIT FOR INTERRUPT

0733                       W1:
0733 E8 076D R                     CALL    PORT_0
0736 42                            INC     DX                      ; PORT_1 ADDRESS
0737 EC                            IN      AL,DX                   ; READ THE HARDWARE STATUS
0738 A8 20                         TEST    AL,020H                 ; DID INTERRUPT OCCUR
073A 75 0A                         JNZ     W2                      ; JUMP IF YES

073C E2 F5                         LOOP    W1                      ; INNER LOOP
073E 4B                            DEC     BX
073F 75 F2                         JNZ     W1                      ; OUTER LOOP

0741 C6 06 0074 R 80               MOV     DISK_STATUS,TIME_OUT
0746                       W2:
0746 4A                            DEC     DX                      ; ADDRESS PORT 0
0747 EC                            IN      AL,DX                   ; READ THE STATUS BYTE
0748 24 02                         AND     AL,2                    ; ISOLATE THE ERROR BIT
074A 08 06 0074 R                  OR      DISK_STATUS,AL          ; SAVE IN THE STATUS
074E 83 C2 03                      ADD     DX,3                    ; PORT_3 ADDRESS
0751 32 C0                         XOR     AL,AL                   ; ZERO
0753 EE                            OUT     DX,AL                   ; RESET INTERRUPT MASK
0754 C3                            RET

0755                       WAIT_INT        ENDP

                           ;---  HD_INT  -------------------------------------------
                           ;                                                       :
                           ;           FIXED DISK INTERRUPT 0DH ROUTINE IRQ-5      :
                           ;                                                       :
                           ;--------------------------------------------------------

0755                       HD_INT  PROC    NEAR
0755 50                            PUSH    AX                      ; SAVE WORK REGISTER
0756 B0 07                         MOV     AL,07H                  ; SET DMA MODE TO DISABLE
0758 E6 0A                         OUT     DMA+10,AL
075A FA                            CLI                             ; NO INTERRUPTS
075B E4 21                         IN      AL,INTA01               ; LOAD THE INTERRUPT ENABLE MASK
075D 0C 20                         OR      AL,020H                 ; TURN OFF FIXED DISK IRQ-5
075F E6 21                         OUT     INTA01,AL               ; REPLACE THE MASK
0761 B0 20                         MOV     AL,EOI                  ; LOAD THE END OF INTERRUPT MASK
0763 E6 20                         OUT     INTA00,AL               ; CLEAR THE ACTIVE INTERRUPT LEVEL
0765 FB                            STI                             ; INTERRUPTS BACK ON
0766 B8 9100                       MOV     AX,9100H                ; DEVICE POST
0769 CD 15                         INT     15H                     ;  INTERRUPT
076B 58                            POP     AX                      ; RESTORE AX
076C CF                            IRET
076D                       HD_INT  ENDP

                           ;----------------------------------------
                           ; PORTS                                 :
                           ;       GENERATE PROPER PORT VALUE      :
                           ;       BASED ON THE PORT OFFSET        :
                           ;----------------------------------------

076D                       PORT_0  PROC    NEAR
076D BA 0320                       MOV     DX,HF_PORT              ; BASE VALUE
0770 02 16 0077 R                  ADD     DL,PORT_OFF             ; ADD IN OFFSET VALUE (00,04,08,0C)
0774 C3                            RET
0775                       PORT_0  ENDP

0775                       END_ADDRESS     LABEL   BYTE
0775                       CODE    ENDS
                                   END
```